Natick Soldier Center (NSC)
DoD Combat Feeding Program

Radio-Frequency Identification (RFID) Technology Demonstration

23-26 February 2004

Initial Observation Report
28 February 2004

Approved for public release; distribution unlimited

FOREWORD:

The planning and successful completion of the Department of Defense's (DOD) Class 1 (Subsistence) Radio Frequency Identification (RFID) technology demonstration was indeed a massive undertaking. We wish to acknowledge the on-site partners for making this possible:

CW3 (P) Stephen Moody, Project Leader, Natick Soldier Center (NSC) Combat Feeding Program (CFP)
Mr. Harry Kirejczyk, NSC CFP
Dr. Bruce Wright, NSC CFP
Mr. Karl Waldman, VP, OatSystems (Systems Integrator)
Mr. Vikram Parvataneni, OatSystems
Mr. Anup Mantena, OatSystems
Mr., Guillaume Boissiere, OatSystems
Mr. Mark McDonald, Alien Technology (Hardware Development, Technical Support)
Dr. Daniel Engels, Director, Massachusetts Institute of Technology Auto-ID Labs
Mr. Richard Crutcher, Oak Ridge National Labs (Independent Technical Assessment and Support)
COL Edward Visker, CDR, Defense Depot San Joaquin (DDJC), and his entire tech demo support team

Their collective efforts resulted in the ability to effectively use RFID technology to track inventory and determine Class 1 quality from "vendor to foxhole". It was abundantly clear that a true partnership brings true value.

Gerald A. Darsch, Director Combat Feeding
gerald.darsch@natick.army.mil

Kathy Evangelos, Executive Assistant
kathy-lynn.evangelos@natick.army.mil

INTRODUCTION:

This RFID technology demonstration is the culmination of a three-year research project in conjunction with the MIT Auto-ID Center and in cooperation with the Defense Logistics Agency. OatSystems, Inc. is the contracted systems integrator for the demonstration.

Auto-ID RFID technology was developed by MIT Auto-ID Center based on open, global standards that will allow for interoperability, scalability, and ultimately affordability. The key element of this technology is the Electronic Product Code (EPC), which serves as a standard to uniquely identify items in an end-to-end supply chain. This commercial standard, adopted by the DoD, has the potential to drive competition to create an affordable solution for the DoD and commercial industry worldwide.

In accordance with the February 20, 2004 RFID Policy Update, Mr. Wynne, Acting Undersecretary of Defense for Acquisition, Technology, and Logistics, stated in a cover memorandum, “This policy provides….an initial set of business rules for the implementation of passive RFID and the use of EPC compliant tags within the DoD supply chain…these rules include the requirement for DoD suppliers to put passive RFID tags on the cases and pallets of materials shipped to the DoD….”.

OBJECTIVES:

Demonstrate the ability of passive RFID tags to track inventory in an end-to-end supply chain, and the ability of sensor equipped RFID tags to provide quality and shelf life data.

Provide implementable lessons learned to support the final DoD RFID Policy Business Rules for the use of passive RFID in the DoD Supply Chain.

SCOPE:

Vendor/Depot Operations:

Passive tags (915 MHz) were applied to cases and pallets of Meals, Ready to Eat (MRE) and Unitized Group Rations (UGR) to uniquely identify each case and pallet via an EPC. Battery Assisted Passive (BAP) tags (2.45 GHz) (also referred to as semi-passive) with temperature sensors were applied to pallets. Case level EPC data was wirelessly aggregated to BAP pallet tags with software association of case level data to each pallet. BAP tags were applied to 8x8x20 containers. Pallet data was electronically associated with the container as it was loaded. BAP pallet tag data (individual pallet EPC and quality indices) was aggregated to the BAP container tag. Container tags uniquely identified each shipment and contained data sufficient to generate a Transportation Control and Movement Document (TCMD). Depot inventory was automatically adjusted as products were received and shipped.

General Support Supply Point (GS) Operations:

Container tags were read upon receipt and the GS inventory was updated with incoming material. Containers were opened and BAP pallet tags read to update the quality indices for the pallets in the container. Pallets were removed from containers and moved to a GS bulk storage area. GS pick lists were generated based on shortest remaining shelf life. Pallets were then moved through a portal reader to the issue area, and reconfigured onto a flatbed trailer. Pallet level data was aggregated to the conveyance tag as it was at the depot.

Direct Support Supply Point (DS) Operations:

Conveyance tags were read upon receipt and DS inventory updated with incoming material. Pallets were then received into a DS bulk storage area. Pallets were then moved through a portal to the issue area, where individual unit requisitions (unit piles) were assembled and scanned using a hand held reader. Individual case EPC's were associated with the unit as they were issued.

Inventory Tracking

Real-time inventory tracking was available throughout the entire end-to-end supply chain.

LOGISTIC NODES:

Ten logistic nodes within a simulated “vendor to foxhole” supply chain were instrumented with RFID readers. These locations were identified to enable adequate track and trace of Class 1. These nodes and their objectives are delineated below.

Station 1 - Case Commissioning-Pallet Building: The objectives of station 1 were to apply a passive tag and assign a unique EPC to individual cases of product, build pallets, assign a unique “check tag” which identifies a full pallet, commission the pallet BAP tag, and write the pallet manifest to that tag. Built pallets are automatically added to the depot inventory.

Station 2 - Container Loading: The objective of station 2 was to commission a conveyance BAP tag with TCMD data, load a container with pallets, and automatically write the container manifest to the conveyance tag. Pallets loaded into a container are automatically removed from the depot inventory and added to the in-transit inventory.

Station 3 - GS Supply Point Entry: The objective of station 3 was to identify the conveyance tag and read its manifest data as the container entered the GS. All pallets contained in the manifest are automatically added to the GS bulk storage inventory.

Station 4 - Quality Update: The objective of station 4 was to determine the quality of the MRE’s and UGR’s contained in a container. The temperature data from a single BAP pallet tag within the container is read, and the estimated quality of that pallet is determined via a shelf-life model, which applies to all pallets within the container.

Station 5 – Issue Portal: The objective of station 5 was to identify all pallets as they are moved into the issue area of the GS via the check tag.

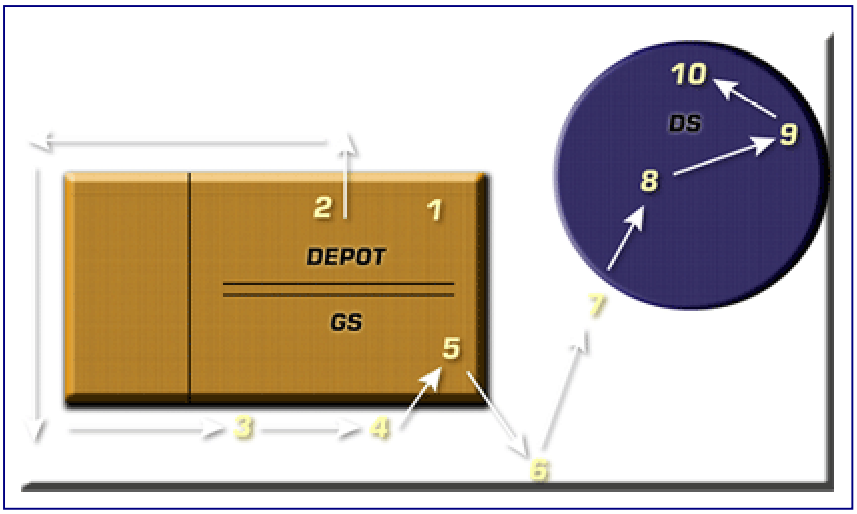
Station 6 – Flatbed Loading: The objectives of station 6 were commission the flatbed BAP tag, load the flatbed trailer with pallets, read the pallet BAP tags and automatically write the new manifest to the flatbed tag.

Station 7 – GS Supply Point Exit: The objectives of station 7 were to read the flatbed BAP tag as it exits the issue area and to automatically decrement the GS inventory.

Station 8 - DS Supply Point Entry: The objectives of station 8 were to read the flatbed BAP tag and its manifest data using a portable reader. All pallets contained in the manifest are automatically added to the DS inventory.

Station 9 – Issue Portal: The objective of station 9 was to identify pallets after they were removed from the flatbed and moved into the DS issue area via the check tag.

Station 10 – Unit Issue: The objective of station 10 was to construct unit piles and verify the correct inventory of each unit requisition in the DS issue area using a hand-held reader. DS inventory was automatically reduced.



Warehouse 29, DDJC – Station Locations

SUMMARY OF RFID DEMONSTRATION:

This DoD Class 1 RFID technology demonstration confirmed the capabilities of passive and semi-passive RFID tags and the EPC Network to track and trace inventory, in real time, as the products move throughout this simulated DoD supply chain. Overall, objectives were achieved at each station throughout the demonstration. The demonstration highlighted both the capabilities and the limitations of the technologies used. While some existing technologies are immature, they are clearly capable of being developed further to meet both commercial and military requirements to apply RFID within their respective supply chains.

Tech demo based upon EPC implementation of RFID technology:

- EPC Class 1 Generation 1 passive tags
- BAP temperature/manifest tags with EPC identifier

Wide-ranging processes demonstrated:

- Case and pallet commissioning
- Shipping process
- In-transit visibility
- Receiving
- Unit issue
- Product quality (environmental)

Complexity of integration pushed the envelope beyond previous demonstrations:

- Fixed portal and handheld portable readers for Class 1 tags
- Fixed portal, forklift mounted, and portable readers for BAP tags
- Simulation of product flow through three tiers of operations
    - Depot
    - General Support
    - Direct Support

- Implementation of Senseware™ to track product and inventory through entire process
- Extensive use of wireless communications in conjunction with RFID

Results:

- High success rate in writing passive tags
- Case and pallet tagging and commissioning is a moderately mature process
- Shipping related operations (container/trailer loading) with BAP is still immature
- In-transit visibility of containers and trailers worked reliability (entry/exit portals)
- Use of BAP for logging temperature coupled with shelf-life models predicted product quality
- Handheld portable passive readers exist but need to mature before applicable to either depot or deployed operations
- Seamless integration across all hardware and software processes is essential

Issues to Overcome:

- Wireless communications (802.11b) lacks robustness in high RF interference environment
- Interference among non-coordinated RFID readers in close proximity can affect reliability (adjacent dock door portals, portables, forklift readers)
- Portable handheld readers hold promise but immaturity (range, directivity, user interface, lack of wireless connectivity) currently limits potential usefulness

Final RFID technology demonstration detailed technical assessment to be prepared by ORNL.

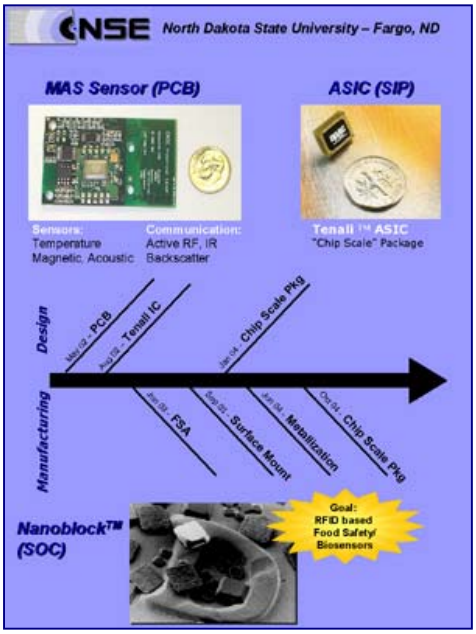
STATIC DISPLAYS:

A static display featured a prototype RFID hand-held reader to aggregate 915 MHz Alien Class1 EPC passive tags to the current DoD 433 MHz Savi active tag.

Kathy Evangelos demonstrates the capability of the hand-held reader

BG Gainey, CG, DDC and COL Visker observe the demo

Revolutionary advances in RFID and sensor technology currently under development at North Dakota State University were also on display.



KEY POINTS OF VIEW:

"The work that Kathy Evangelos, Gerry Darsch, and the entire Combat Feeding team have done in our RFID pilots is truly leading edge. Thanks to their efforts, the DoD continues its global leadership in RFID applications. The recent work at DDJC continues to demonstrate the value and opportunities for transforming the DoD supply chain. Their leadership and commitment to technical and operational excellence are a tremendous asset to our nation and our warfighters".

Brad Berkson
DUSD LMR (Acting)
28 February 2004

"I commend the Natick Soldier Center Combat Feeding Directorate for successfully conducting the definitive RFID proof of principle to dramatically enhance DoD's capability for end to end logistics."

Alan Estevez
DUSD LMR SCI
26 February 2004

"The reach and clarity that product level RFID provides to enhance logistics decision making is a key ingredient for improving sustainment to the battle space. It's clearly the way ahead for effective E2E distribution based logistics."

COL Edward Visker
Cdr, DDJC
26 February 2004

"The results of this RFID demo have made it clear to me that it is the next logical step in the pursuit of logistical performance. Upon refinement, I believe that RFID will certainly become the industry standard for streamlining the supply chain and will significantly enhance customer support."

Renee Narnajo
Materials Handler (Fork Lift Operator)
DDJC
26 February 2004

PHOTO ESSAY:

Station 1

Commissioning passive tags

Station 1

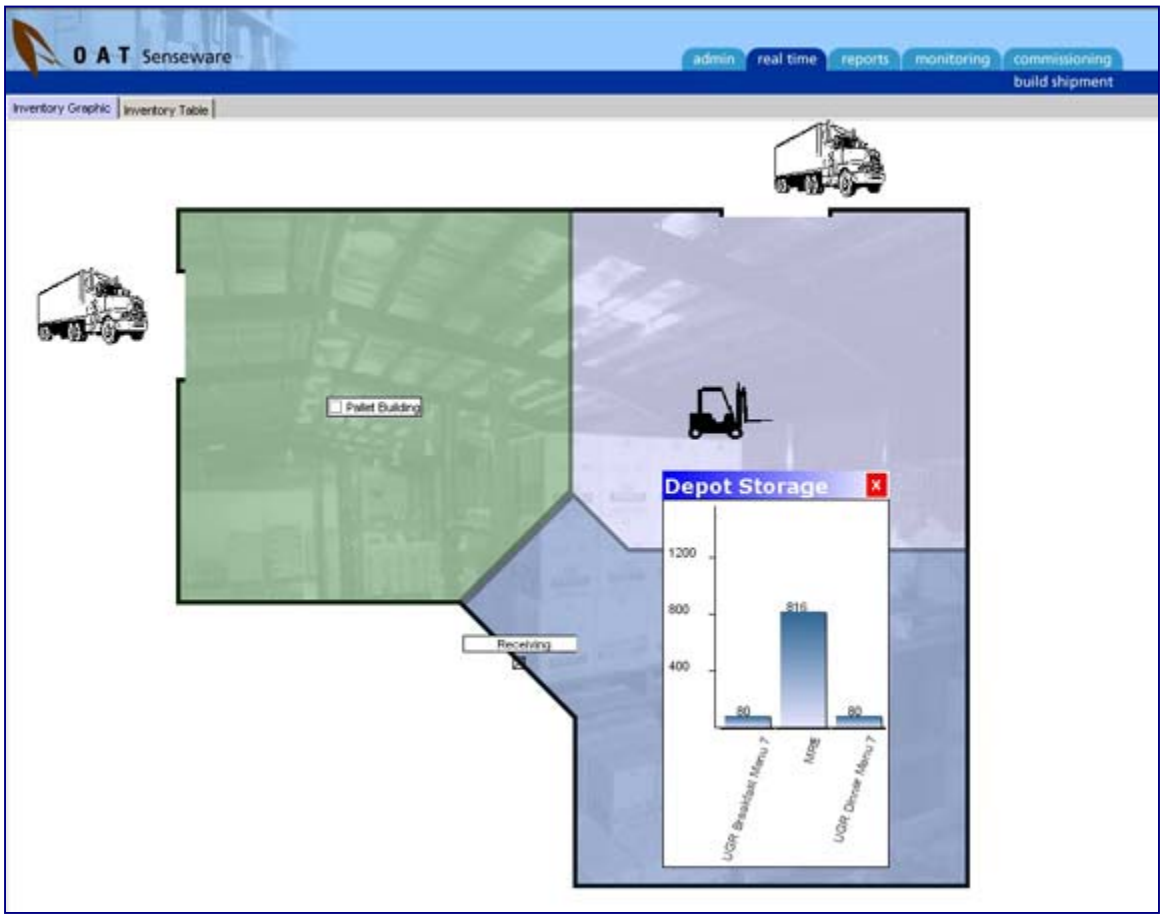
Close-up of writing EPC to passive tag

Station 1

Pallet building, check tag in center of middle case

Station 1

Senseware™ screen shot of initial state of depot inventory



Station 2

CW3 (P) Moody explains the prototype RFID enabled forklift

Station 2

RFID enabled forklift commissions container tag with TCMD

Station 2

Close-up of BAP conveyance tag

Station 2

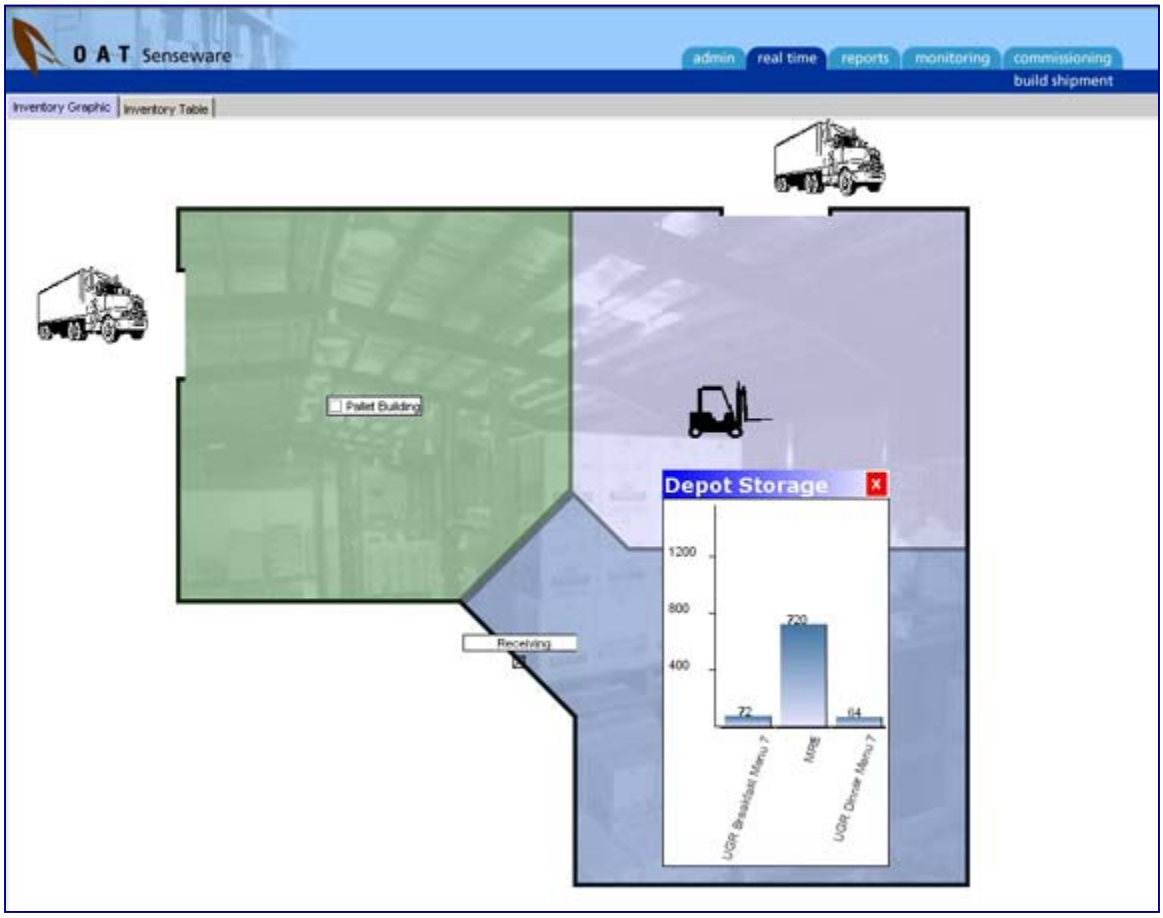
Loading container with RFID enabled forklift and writing pallet tags to conveyance BAP tag

Station 2

Departure from vendor/depot

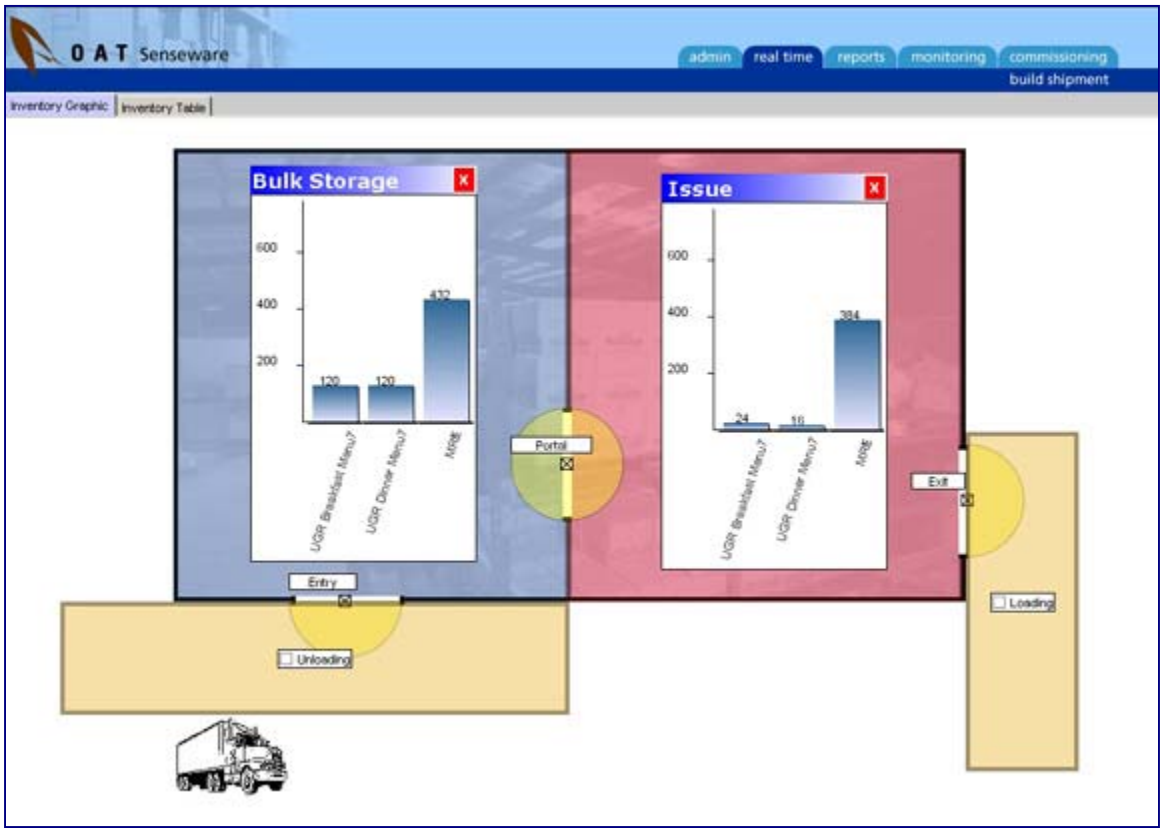
Station 2

Vendor/depot inventory automatically reduced after loading and shipping a container



Station 3

Initial state of GS inventory prior to arrival of vendor/depot container

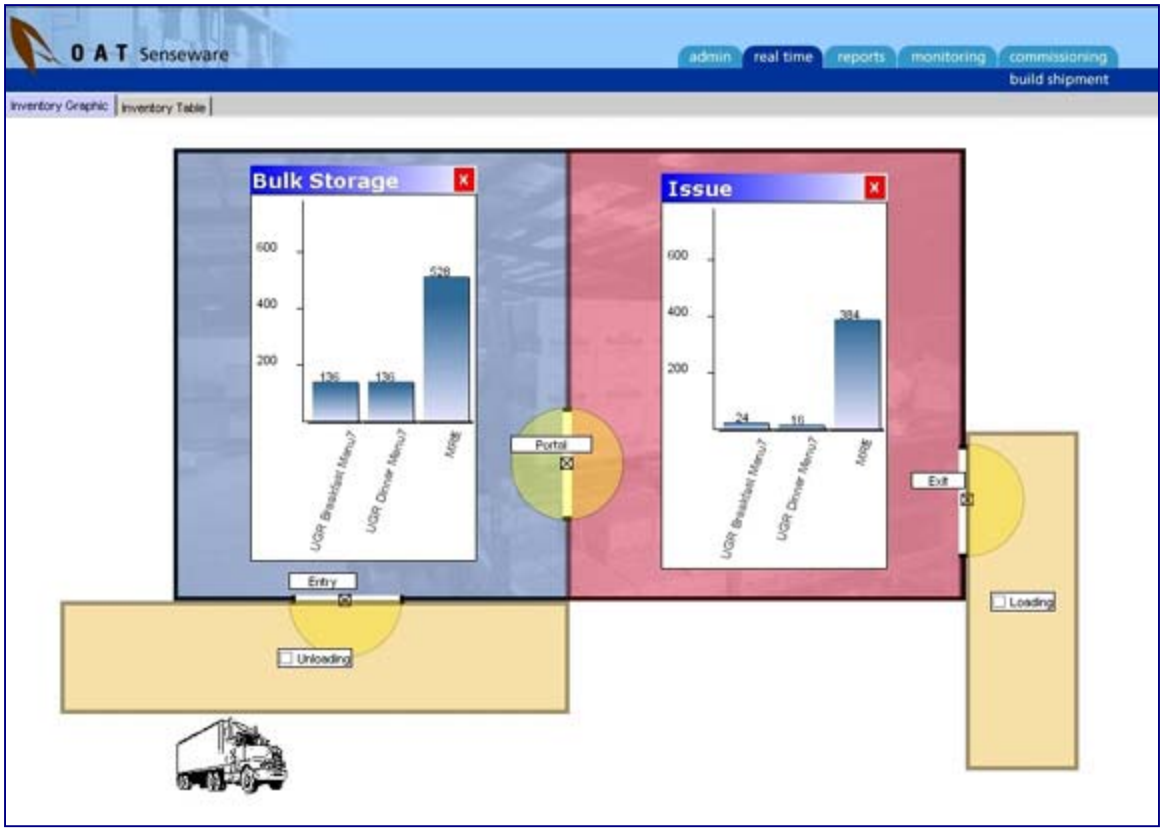


Station 3

Arrival at GS entry, light stack turns green

Station 3

After receiving the container built at the depot, GS bulk storage increases

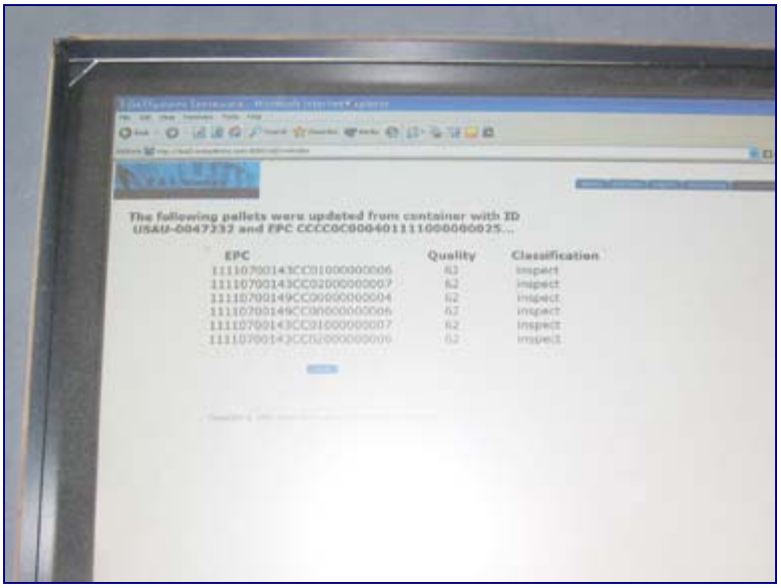


Station 4

Portable reader interrogates pallet BAP tag and downloads temperature profile

Station 4

Screen shot of quality assessment of UGR's using shelf-life model



Station 4

Mr. Brad Berkson and others view quality assessment

Station 5

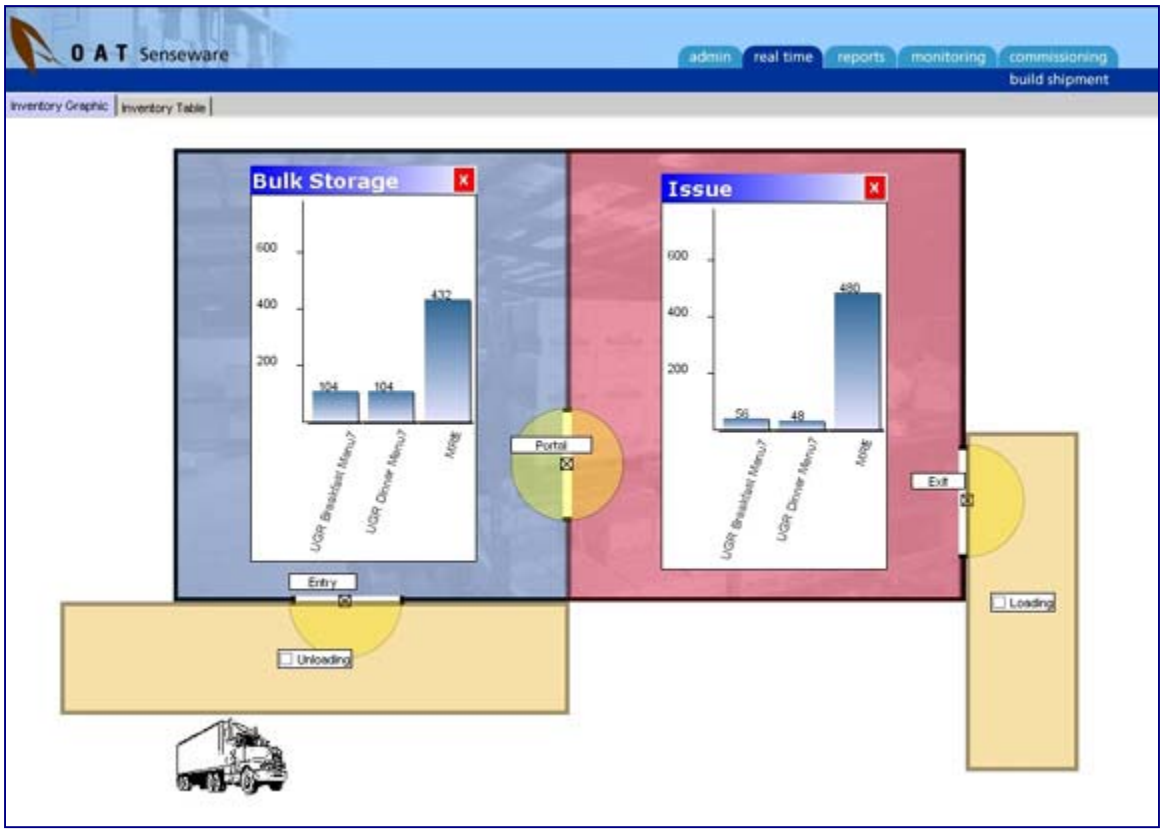
Container offload to GS bulk storage

Station 5

Moving product from GS bulk to GS issue using conventional forklift, check tag read

Station 5

Inventory after transfer from GS bulk to GS issue



Station 6

Flatbed loaded with DS requisition, reading pallet tags with portable reader

Station 6

Gerry Darsch explains functionality of pallet BAP tags to Mr. Berkson, DUSD LMR (Acting) and Mr. Brandler, Director NSC

Station 6

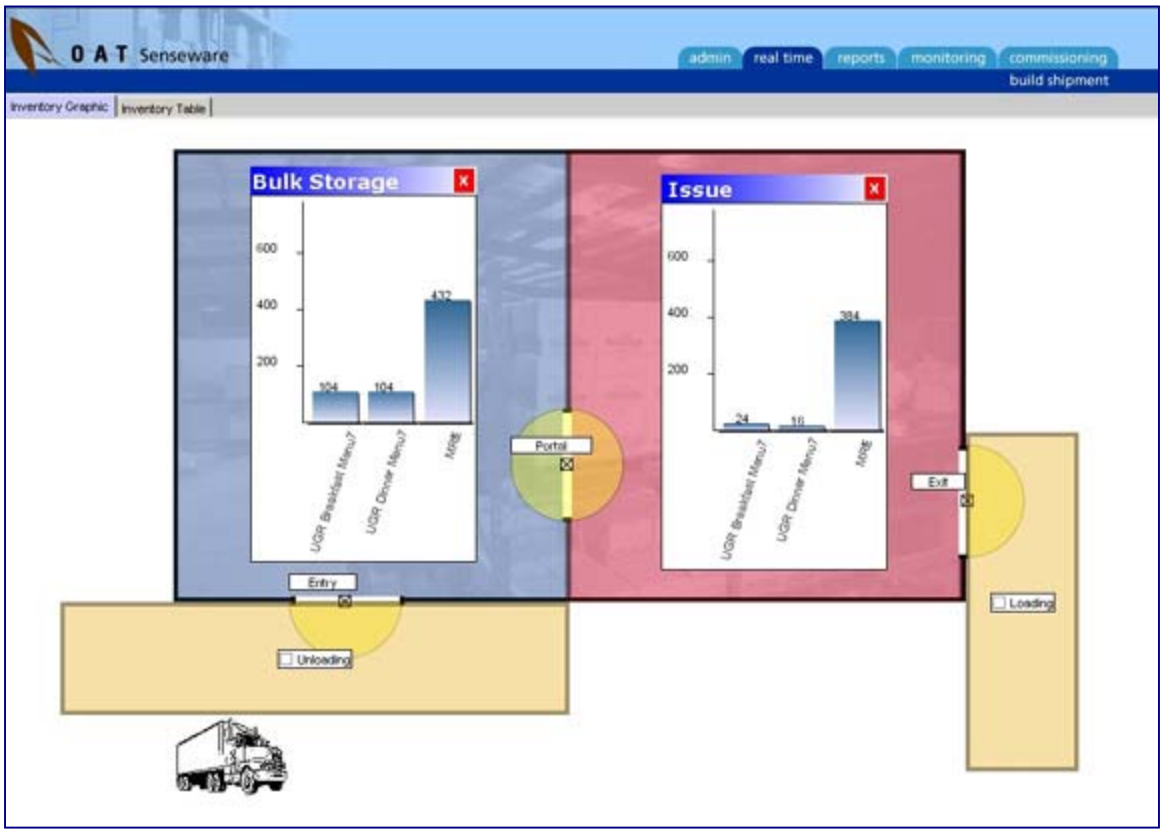
After commissioning conveyance tag, pallet BAP tags are written to flatbed BAP tag with portable reader

Station 7

Departure from GS, light stack turns green when BAP conveyance tag is read

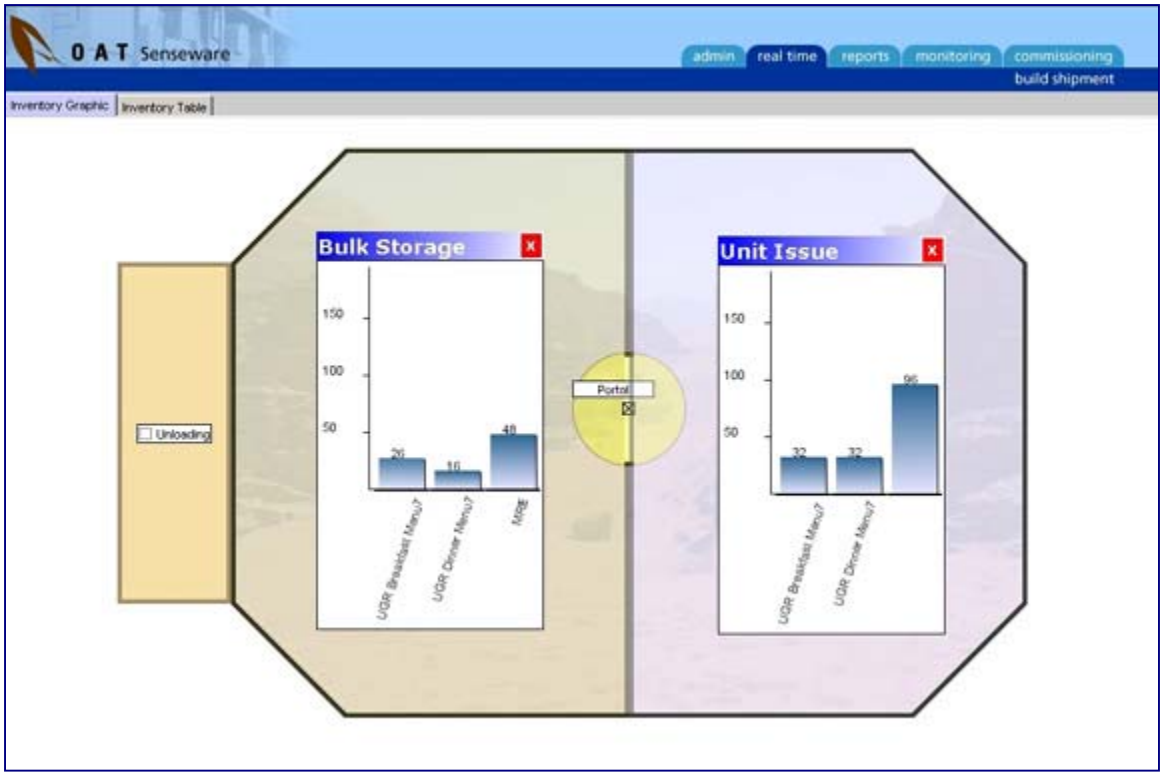
Station 7

GS inventory decremented after flatbed exits GS, Senseware™ screen signifies cargo in-transit



Station 8

Senseware™ screen indicates initial DS inventory

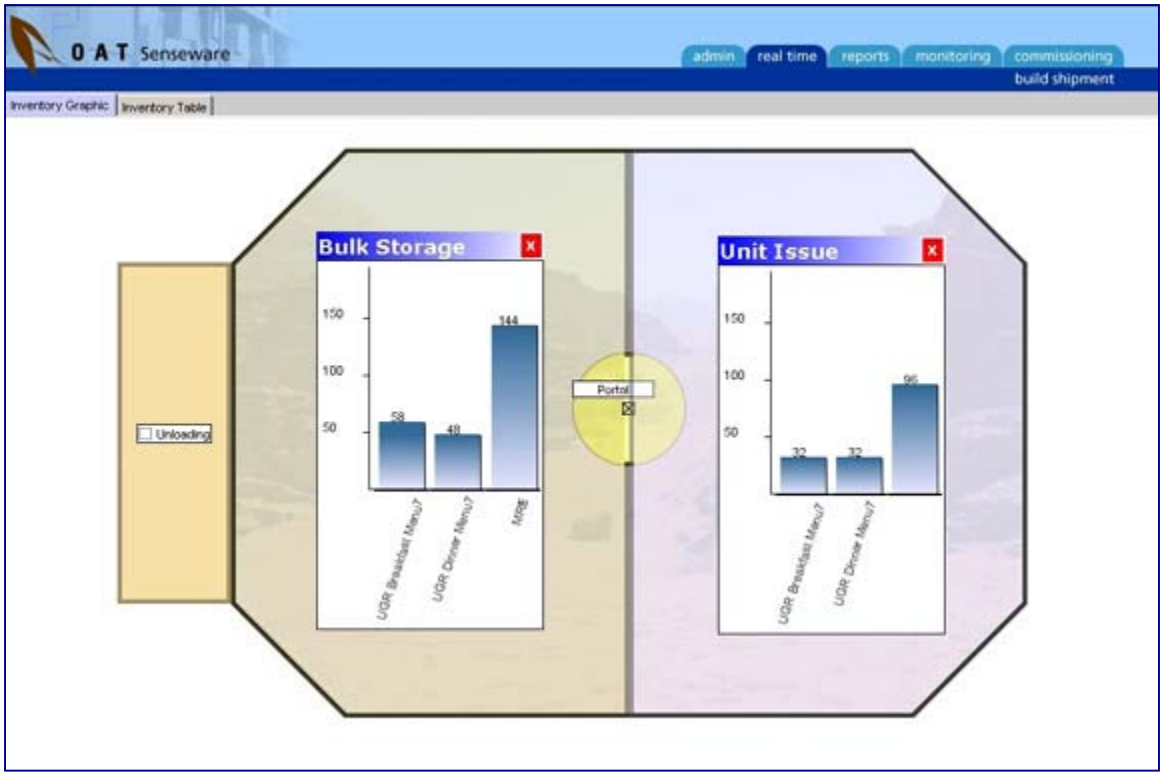


Station 8

DS entry, portable reader interrogates flatbed BAP and increases DS inventory

Station 8

Senseware™ screen signifies increase to DS bulk inventory



Station 9

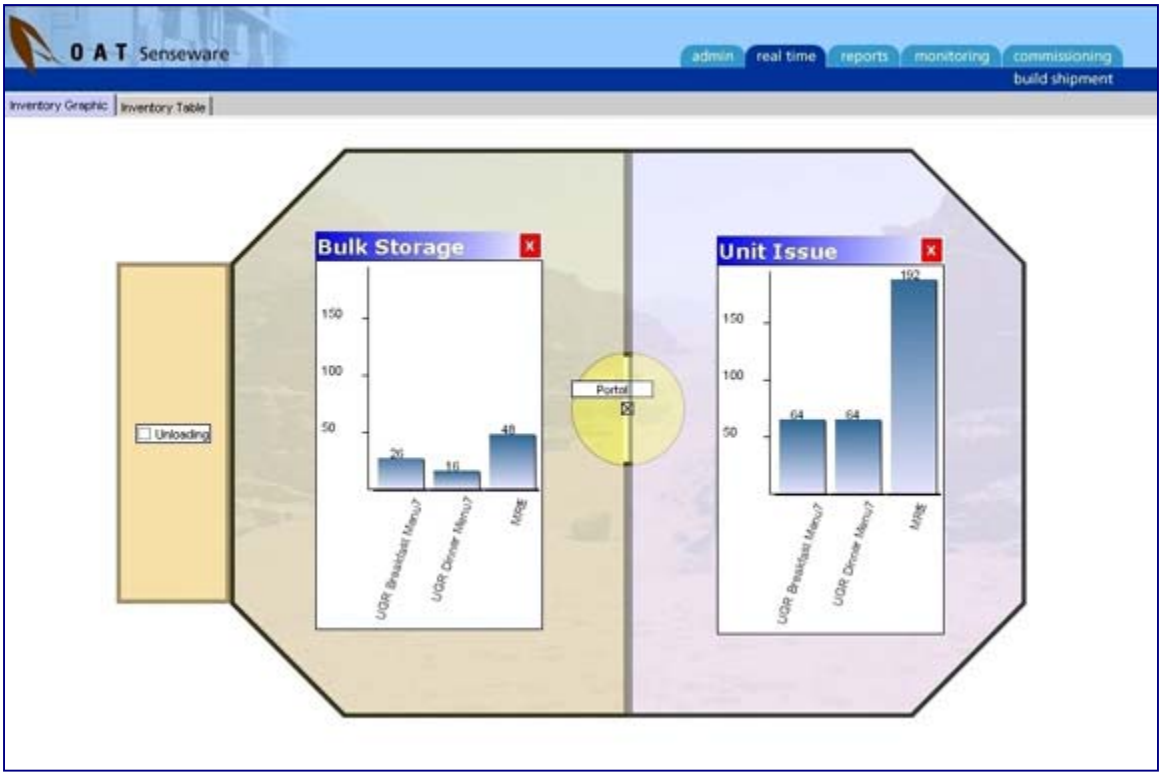
Conventional forklift unloading pallets to be placed in DS issue

Station 9

Conventional forklift moving through DS portal to DS issue, check tag read

Station 9

Senseware™ screen signifies increase to DS issue inventory and decrements DS bulk



Station 9

Unloading pallets in preparation to build unit piles for unit issue

Station 10

Unit requisitions being built

Station 10

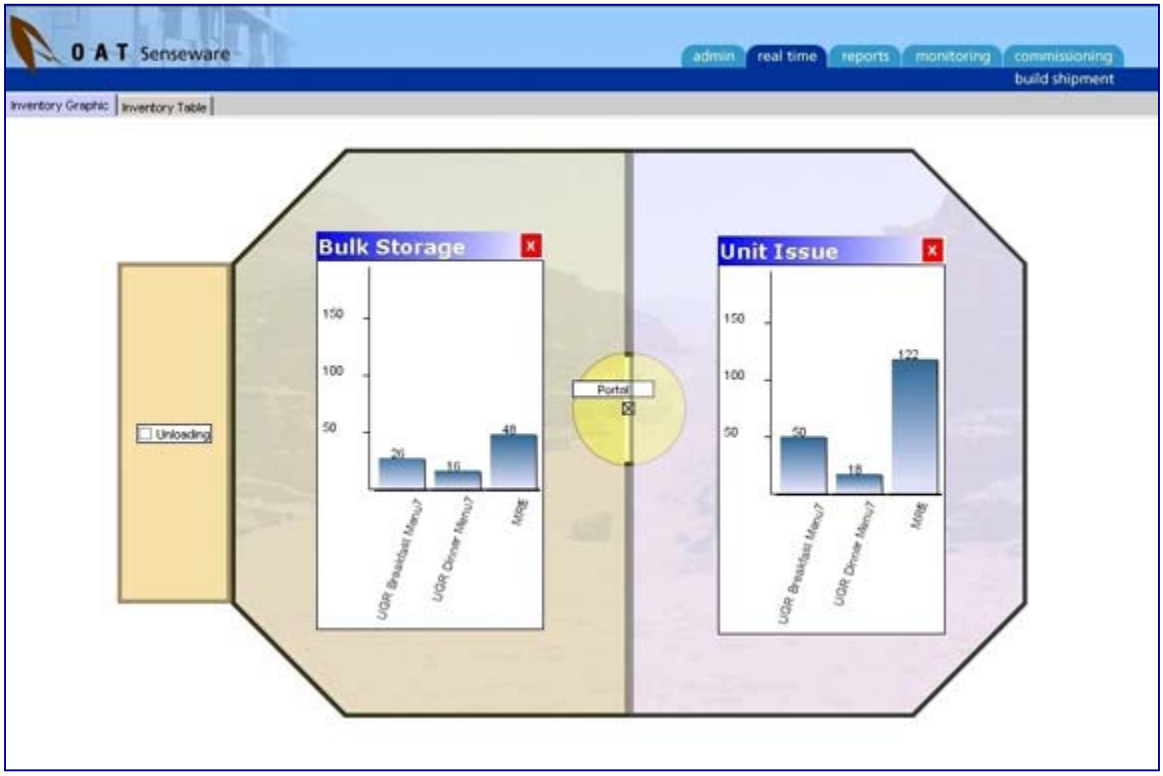
Scanning unit requisition using hand-held reader

Station 10

Mr. Estevez, DUSD LMR, SCI successfully scans a unit requisition

Station 10

Senseware™ screen signifies decrease to DS inventory



Stations 1-10

Remote access via the web enables real-time inventories from “vendor to foxhole”, providing the Class 1 Theater Manager Total Asset Visibility

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